15 cm below the surface and carefully extracted to collect the sample. If deemed necessary, a sealing device will be used to retain the sample within the corer until it can be transferred to a container.

Following coring, the samples will be sieved through a 0.5 mm mesh box sieve for separating the mole crabs and coquina clams in the field. All samples will be retained in the sieve box and prepared for laboratory analysis. The samples will be fixed in a 10% buffered formalin solution mixed with Rose Bengal protein dye, sealed, labeled and transported to the laboratory for analysis. The sample will be fixed in the solution for at least 48 to 72 hours before sorting amphipods and polychaetes. Species will be identified to the lowest possible taxonomic level. After analysis, the samples will be transferred to a 50% isopropynol preservative for long-term storage.

6.2.5 Data Analysis and Report Preparation

Infaunal data for each station will be reported as the number of individuals from each taxon, the number of species and the total number of organisms per square meter. Brief descriptions of the types of diversity indices to be used during this study are provided below.

A. Shannon-Weaver (Shannon) Index of Diversity: The base 2, base 10 or natural log statistic will be used in defining the diversity of species. This index is based on the "information" theory, where diversity is equated to the amount of uncertainty that exists on the identity of an individual collected at random from a community. The more species and the more evenly the presentation of individuals, the greater the uncertainty and the greater the diversity (Milligan, 1990). The higher the Shannon-Weaver Diversity Index, the higher the species of diversity and the higher the equitability.

B. Simpson Diversity Index: This index emphasizes the degree of dominance by one or a few species and provides the probability that two individuals drawn at random from the same community are the same species (Levington, 1982). Consequently, the higher the Simpson Diversity Index, the higher the degree of dominance by one or a few species, and the lower the species diversity and equitability.

C. Pielou Index of Equitability: Equitability is considered a component of diversity in that it provides an idea about the evenness of species distribution at a site. Usually, a positive

correlation exists between diversity and equitability (i.e., high equitability would indicate high diversity) (Milligan, 1990).

D. Margalef's Index: Margalef's Index assumes a relationship between the number of individuals and the number of species in a sample. This index logarithmically scales the value of the number of species, and provides a comparison between stations with different ratios of number of species and individuals (Milligan, 1990).

Data analysis and observations obtained from each station will also include the following information: sampling device used; size and depth of the sample collected; and any other identifiable tubes, mound structures, fecal coils. Pre-project baseline data will be used in the evaluation of population regeneration following the dredge and fill operations at both the existing and proposed channels.

Annual reports documenting the findings will be prepared simultaneously with the saltmarsh monitoring report (see Appendix H). Reports will be submitted to the USACE on February 30th of any year.

6.3 SALTMARSH MONITORING PROGRAM

6.3.1 Purpose and Goals

The following sampling and monitoring plan has been developed in support of an Environmental Impact Statement for the Bogue Inlet Channel Erosion Response Project. The monitoring plan is intended to address the need for data collection and analysis of the adjacent saltmarsh communities in the vicinity of the project area.

The monitoring plan will provide information on coastal marsh habitats that may be directly or indirectly affected by the channel relocation efforts. This plan is intended to support the concerns of the U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service, National Marine Fisheries Service, the North Carolina Division of Coastal Management, the North Carolina Division of Marine Fisheries, and the North Carolina Wildlife Resource Commission.

Monitoring efforts are proposed to assess and document the potential effects of perturbations, such as sedimentation on adjacent saltmarshes. Sampling efforts will concentrate on representative areas of potential impact where biota and physical conditions may be affected by project activities and related effects.

6.3.2 Monitoring Schedule

A total of four years of monitoring will be conducted to determine if impacts are directly or indirectly attributable to project activities. Of that, one year of pre-construction monitoring has occurred. Three years of post-construction monitoring remain. The effects of perturbation on vegetative conditions will be most pronounced during active growth and development periods. Therefore, observations of these effects will be better identified at the end of the growing season (September/October). Pre-construction monitoring at three of the monitoring stations were conducted at the end of the growing season in September 2003 while pre-construction monitoring at a fourth station (south side of Dudley Island) will be conducted in September or October 2004 to collect baseline monitoring condition. Bi-annual saltmarsh monitoring will continue for three-years post-construction at all four monitoring stations.

Post-construction monitoring will occur two times per year during the months of May or June and September or October. The proposed project will be constructed between November 16th and March 31st to limit construction activities during the critical life stages of birds and fish, the turtle nesting and hatching season, the migratory passage of marine mammals, and the flowering stages of plants.

6.3.3 Biological Monitoring Parameters

Saltmarsh and Ecological Monitoring

Monitoring of the selected parameters identified below, along with the infaunal characterization will document and assess the potential effects of project activities on primary productivity in the saltmarsh habitat.

Monitoring Stations

Saltmarsh monitoring transects will be located at the following locations: 1) north of Bogue Inlet on the east side of the main channel, 2) on the east side of Dudley Island, and 3) north of Bear Island and 4) south side of Dudley Island. Refer to Figure 1 for the saltmarsh monitoring stations.

Monitoring Parameters

The following monitoring parameters are based on the potential for indirect impacts to the adjacent salt marsh communities from the channel relocation efforts. Monitoring stations will include control stations of similar vegetation and tidal habitat. The monitoring parameters include:

- *Spartina* sp. stem density,
- Mature (>30 cm in height) *Spartina* sp. stem height,
- Percent sand, silt, and clay of surface substrate,
- Percent organic content of surface substrate,
- Sedimentation rate,

- Wildlife utilization, and
- Channel marsh edge erosion.

Methodology

Three permanent 300 foot monitoring transects will be located in the saltmarsh areas in the vicinity of the project. Five one-meter square quadrats for each transect (located 5, 50, 100, 150, and 300 feet away from the marsh edge) will be sampled for stem density and height of *Spartina*. The transect located on the north side of Bear Island will serve as the relative control site for the other transects. This transect is not expected to exhibit project-related impacts.

Sediments will be characterized based on percent sand/silt/clay and percent organic content. Samples will be collected from the 5, 50, 100, 150 and 300-foot locations along each transect. In addition, graduated PVC piping will be installed prior to project construction to evaluate sediment deposition and/or erosion over time for each plot. The PVC will be exposed 3 to 4 feet above the existing sediment line to account for high sediment accretion rates.

Direct visual observations and indirect evidence will be used to document the presence of epibenthic macroinvertebrates and wildlife along the transect corridors. Each transect corridor will extend 150 feet from the edge of the marsh, roughly perpendicular to the channel, and will be three feet wide. Separate control transect corridors (150 feet by 3 feet) will be established parallel to the channel and intersect the 150-foot quadrat locations.

Organic Content Samples

One substrate sample per quadrat location will be collected to determine the organic content of the sediments. Samples will be collected to a depth of 15cm (10 cm in diameter) and placed in standard soil sample bags. Samples will be shipped to a certified agricultural testing laboratory for analysis of organic content, as well as percent sand/silt/clay.

6.3.4 Report Preparation

Monitoring reports documenting saltmarsh conditions will be prepared simultaneously with the infaunal monitoring report. The annual monitoring reports will be submitted to the USACE on January 1st of each year. Refer to Appendix H for the Saltmarsh Monitoring Report from September 2003.

6.4 HABITAT MAPPING

6.4.1 Purpose and Goals

The following monitoring plan has been developed in support of the Environmental Impact Statement for the Bogue Inlet Channel Erosion Response Project. This

monitoring plan is intended for the identification of submerged aquatic vegetation (SAV), shellfish habitat, salt marsh and fringing terrestrial communities before and after construction is completed. This monitoring plan includes the acquisition of aerial photography, ground-truth investigations, topographic and bathymetric surveys.

Two study areas were identified in order to delineate and differentiate between areas anticipated to receive primary and secondary effects (Permit Area/Project Impact Zone) from work occurring within the Inlet and areas anticipated to receive cumulative effects (Project/Survey Area) from work occurring within Bogue Inlet. These areas assist in defining the level of detail assigned to the mapping efforts described in this plan. This plan was developed in response to the concerns expressed by the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the North Carolina Department of Environment and Natural Resources.

6.4.2 Monitoring Schedule

Pre-project aerial photography was acquired in June 2003. Additional pre-project aerials may be acquired in 2004. Pre-construction ground-truthing investigations for the identification of SAV, shellfish, salt marsh and fringing and terrestrial communities were conducted in September 2003. Post-construction aerial surveys and ground-truth investigations will be conducted 18 months after project completion.

Pre-construction topographic and bathymetric surveys of the terrestrial and aquatic environments were conducted in September and October 2003.

6.4.3 Monitoring Parameters

Aerial Photography

Aerial photographs include the acquisition of ortho-rectified color digital imagery of the entire fourteen square mile Project Area. Resolution of the acquired imagery will be sufficient (< 2 feet) to accurately delineate and map habitats and features of environmental significance within the survey area. An emphasis will be placed on those marine and estuarine habitats located immediately within and adjacent to the project permit area. The aerial platform from which the imagery is acquired will have an onboard Global Positioning System (GPS) that will provide an accurate basis for product correction.

In compliance with State and Federal agency requests, digital image acquisition will be timed, to the greatest extent possible; to coincide with good weather conditions and a flood tide that may provide for increased water quality over the survey area and increased habitat mapping potential. Considering the weather dependent

nature of this activity, every effort will be made to accomplish this task under optimum conditions.

Submerged Aquatic Vegetation

SAV mapping depicts the boundaries of SAV occurrences, but does not attempt to estimate density or classify SAV (by species, community structure, etc.). Dominant species of SAV are noted, but no attempt is made to quantify species composition or relative abundance. This effort assumes that the digital aerial photography is suitable for mapping the boundaries of SAV occurrences accurately.

The extent of mapped SAV in and immediately adjacent to the permit area will be confirmed using visual observations in shallow water and ponar grab sampling in waters where the vegetation and/or bottom is not visible due to decreased water clarity. A GPS unit was used to ascertain the general limits of the SAV occurrences.

Within the broader survey area, SAV communities were preliminarily mapped using the digital aerial photography as previously described. A minimum of ten percent of the SAV communities within the survey area were field investigated using the methods outlined above for the permit area. Extent of field investigations were distributed throughout the survey area and were representative of the size distribution of all preliminarily mapped communities.

Within the permit area, SAV occurrences for pre-construction conditions were mapped by visual interpretation of the aerial photography and comparison with the 1992 photo-interpreted seagrass data provided by NOAA. Post-construction mapping will utilize both the pre-construction aerials and the post-construction aerials obtained 18 months after construction is complete to document changes in community structure.

Salt Marsh and Terrestrial Fringing Communities

Salt marsh and fringing terrestrial (MFT) community boundaries within the permit area were mapped in 2003 through visual interpretation of the digital aerial photography. Marsh habitats were classified as low marsh (dominated by *Spartina alterniflora*) or high marsh (dominated by *Spartina patens*, *Salicornia* spp., etc.). Fringing terrestrial communities are classified as wetland or non-wetland and by general vegetation type (scrub-shrub, pine forest, hardwood forest, mixed forest, dune grasses, and unvegetated sand). Beaches, dunes, and developed areas on Bear Island and Bogue Banks were mapped using existing data sources (Phase 3 Beach Nourishment Project data), RTK (Real Time Kinematics) GPS technology, or aerial photographic mapping as described in this plan. Beaches and dunes on Dudley Island and any other supratidal islands in the permit area were also mapped.

MFT community mapping in the permit area were field investigated via boat access in the nearby channels. Limited field checking on foot was necessary to verify the wetland/non-wetland status of MFT communities. Dominant plant species in each community were noted.

MFT community mapping in the larger survey area was also performed using the methods outlined above for the permit area. Field investigation of MFT communities in the survey area was limited to those communities that are not well-represented in the permit area (i.e., maritime forest on Huggins Island, dredge spoil islands along the Intracoastal Waterway). Because the dredge spoil islands are numerous, a representative subsample of them will be selected for field investigation.

The nature and extent of characterization of each habitat type will vary depending upon whether the habitat falls within the survey area or the permit area.

Shellfish Habitat Mapping

Multispectral photography (June 30, 2003) and NCDMF C004 Shellfish Mapping Program (C004 Map) were used as a guideline to identify two areas of W habitat within the Permit Area. Using North Carolina Division of Marine Fisheries (NCDMF) data and multispectral aerial photography, two shellfish habitat types were identified and surveyed within the Permit Area. The two habitat types mapped are defined by NCDMF as the V (intertidal, hard, vegetated, and without shell) and W (intertidal, hard, non-vegetated, and with shell) strata. A Trimble GPS unit was used to map the locations of the W strata shellfish habitat. The V and W strata were confirmed visually with NCDMF personnel on 11 September 2003 using a stratifying pole and clam rake and mapped using the multispectral photography.

Post-construction ground-truth investigations will involve the use of newly acquired aerial photographs along with the assistance of NCDMF personnel.

Topographic and Bathymetric Surveying & Mapping

Historic survey and control data was acquired and evaluated for utility in development of the pre-construction survey and mapping plan. Select transect locations were identified within the Project Area and submitted to the appropriate State and Federal resource protection and regulatory agencies for review. The intent of this activity was to obtain agency input and approval of the transect locations prior to commencement of field activities.

Prior to the start of the data acquisition activities, survey control reconnaissance was initiated to confirm that adequate control points exist and are undisturbed. RTK (Real Time Kinematics) GPS was used for placement of any new control points required to complete the surveying and mapping proposed to be performed under

this plan. Temporary control points within the Project Area were established as needed to provide a level of accuracy appropriate for this type of mapping effort.

Survey efforts were concentrated within and adjacent to the Bogue Inlet Channel Erosion Response Project area, and included portions of the Atlantic Ocean shorelines of Emerald Isle or Bear Island.

Bathymetric survey operations were accomplished in those areas where water depth exceeds three feet using a survey vessel with centrally located, hull-mounted transducer connected to a single beam fathometer or jet ski equipped with a single beam fathometer. The fathometer was calibrated prior to the start of the survey following manufacturer recommended procedures, including a bar check at the start and end of the each day.

Horizontal positioning of the survey vessel was obtained using a Trimble Real-Time Differential Global Positioning System with differential corrections acquired from the U.S. Coast Navigation Beacon System. For vessel navigation the Coastal Oceanographics "Hypack" system was used to locate the vessel within the Project Area. The fathometer survey trackline was located along the approximate center line and adjacent to each shoreline to document water depths within the navigation and accessible channels of the Permit Area. In those areas where wide variation in depth contours were observed, an additional random line through the channel was surveyed and used to obtain additional data needed to accurately document the conditions at the time of the survey. All data collected using the single beam fathometer was tide corrected using observed tide levels obtained from a tide level station established within the study area.

Marsh or Back-Bay surveys were conducted using RTK GPS data acquisition system to collect horizontal and vertical survey data. In the event that soft sediments in the marshes or back-bays prevented the accurate acquisition of survey data, a 5-inch aluminum plate was attached to the base of the survey rod to assure that the readings collected were at the surface and did not allow the rod to sink into the marsh.

6.4.4 Reporting

The final product to be delivered under this phase of the project was a rectified (georeferenced) color seamless and tonally balanced mosaic image.

Based on the results of the post-construction field investigations, a habitat map will be developed and revised as necessary. Results of the mapping efforts will be incorporated into the Global Information System (GIS) database developed for this project. Pre-construction mapping results are provided in Appendix H and are also available in a GIS database (CD under a separate cover).

6.5 WATERBIRD MANAGEMENT PLAN

The following Draft Waterbird Management Plan is in final review with the U.S. Fish and Wildlife Service, North Carolina Division of Coastal Management and North Carolina Wildlife Resource Commission (see below).

Bogue Inlet Channel Erosion Response Project
Final Environmental Impact Statement

Draft Bogue Inlet Waterbird Management Plan

Carteret County, North Carolina

Prepared for:
Town of Emerald Isle, NC

Prepared by:
North Carolina Wildlife Resources Commission
and United States Fish and Wildlife Service

January 2004

Bogue Inlet Channel Erosion Response Project
Final Environmental Impact Statement

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1. Purpose and Need

The Town of Emerald Isle, Carteret County, North Carolina, located on the western end of Bogue Banks, is proposing to relocate the main ebb tide channel in Bogue Inlet. Since about 1984 the channel has migrated in an easterly direction causing erosion and threatening infrastructure and development on the western end of Emerald Isle in the area known as The Point. The Town's preferred solution is to relocate the channel to a central location within the inlet, and use sediments from the dredging of the new channel to build a dike across and close the old channel. In addition, the Town would like to use remaining dredged sediments to nourish the Phase 3 portion of the Bogue Banks Beach Nourishment Project area (i.e., approximately four miles of beach along the western end of the Town of Emerald Isle).

The Bogue Inlet complex is extremely valuable to waterbirds. In 1998, the Bogue Inlet shoal system encompassed 250 acres and was classified as the eighth largest inlet shoal system in North Carolina in terms of habitat available to avifauna (USFWS, 2002). The North Carolina Wildlife Resources Commission (NCWRC) has surveyed the inlet area, including the west end of Emerald Isle, the east end of Bear Island and natural islands within the inlet, for breeding waterbirds and found significant numbers of nesting least terns (*Sterna antillarum*), common terns (*Sterna hirundo*) and black skimmers (*Rynchops niger*), all of which are species of concern in North Carolina. Wilson's plovers (*Charadrius wilsonia*), another species of concern, also nest within the project area.

From the limited surveys for non-breeding waterbirds that have been conducted, it is clear that piping plovers (*Charadrius melodus*) use the habitat in Bogue Inlet during migration and winter. Piping plovers are regularly seen on the west end of Bogue Banks, the east end of Bear Island and on Island #2 (a state owned natural island) with as many as 16 individuals recorded during a single survey (i.e., a one-day survey). Piping plovers are regularly seen around Bogue Inlet from July through April, but can be observed during all months of the year. Records of banded birds show that individuals from the Atlantic and Prairie Canada and the endangered Great Lakes populations utilize the area. The Bogue Inlet complex, including the western end of Bogue Banks, the sandy shoals north and adjacent to Bogue Banks, and the eastern portion of Bear Island, is listed as critical habitat for wintering piping plovers (USFWS, 2001).

The proposed project to relocate the channel in Bogue Inlet has the potential to negatively impact migrating, wintering and nesting waterbirds, including piping plovers, in the Bogue Inlet area. One negative effect will be increased disturbance to shorebirds and colonial waterbirds on the spit on the western end of Emerald Isle. Currently, due to the eroded shoreline and the placement of sandbags in front

of several houses at The Point, there is very limited public access to the land adjacent to the inlet. Increased disturbances to roosting, foraging and nesting colonial waterbirds and shorebirds will result from the reestablishment of access to the inlet shoreline once the old channel closes and the inlet shoreline accretes. Two state-owned islands, currently managed by NCWRC to benefit waterbirds, may also be impacted. Island #1 sits just off of the west end of Emerald Isle and is predicted to connect to the mainland once the old channel closes. Island #2 may also be impacted since the channel would be realigned to a position close to the eastern side of the island.

The purpose of this waterbird habitat management plan is to outline a strategy to protect waterbirds and waterbird habitat within the Bogue Inlet area. Since this project has the potential to impact the quality and quantity of habitat available to breeding and non-breeding waterbirds, it is important to manage habitat after the project is complete to minimize any negative impacts. These goals can be met by hiring a year-round contract biologist to implement the plan. The project area encompasses the western portion of Bogue Banks, the eastern portion of Bear Island, Dudley Island, and intertidal and supratidal habitat within the inlet, including Islands #1 and #2. Most of the work for this plan will be conducted on the spit at the west end of Bogue Banks since this area is likely to see the greatest changes to habitat quality. But protection of habitat will also occur at other important sites within the inlet complex (e.g., Bear Island) with help and cooperation from Hammocks Beach State Park (HBSP). This is an adaptive management plan and annual assessment will be required to determine its effectiveness. If it is determined that the plan is not effective as implemented, new strategies will be discussed and implemented as necessary. Any necessary changes to this management plan will be conducted in a manner that works within the existing budget to the greatest extent possible. Changes requiring additional funds will not be implemented without the approval of the Town of Emerald Isle.

2. Species Occurrence

The term waterbird refers to any bird species that uses aquatic habitat. Many species of waterbirds occur within the Bogue Inlet area. The most abundant are shorebirds and colonial waterbirds and species of both groups utilize habitat within Bogue Inlet for nesting, foraging and roosting. Shorebirds are a group of migratory birds that can mostly be found along shorelines but also occur inland, upland, on artic tundra and at sea. Sandpipers (family Scolopacidae) and plovers (family Charadriidae) are commonly referred to as shorebirds but this group also includes oystercatchers (family Haematopodidae), and avocets and stilts (family Recurvirostridae). Colonial waterbirds nest in large groups called colonies and include gulls, terns and skimmers (family Laridae), herons and egrets (Family

Ardeidae), ibis (Family Threskiornithidae), and pelicans (family Pelecanidae). A list of species that commonly occur around Bogue Inlet is given in Table 2.

3. Objectives

To protect waterbirds and their habitat in Bogue Inlet, several objectives need to be met. They are as follows:

1) Identify and protect nesting habitat for waterbirds.
2) Protect high quality foraging and roosting habitat for waterbirds.
3) Monitor/research breeding and non-breeding waterbirds after channel construction.
4) Prevent human and animal disturbance to waterbirds throughout the year.
5) Educate the public about waterbirds and the importance of the Bogue Inlet area for waterbirds.

4. Land Ownership

In order to successfully implement the waterbird management plan, it is important that land ownership of newly created and existing habitat be accurately determined. Currently, any new land that is created as a result of this project will be deeded to the Town of Emerald Isle and put under a conservation easement to prevent future development of the area. In addition, the Town's property boundaries will be amended to include the spit so that the Town can enact and enforce ordinances in this area. Since all existing and newly created habitat will be under public ownership, implementation of the waterbird management plan will be simplified.

5. Protection of Nesting Habitat

5.1 *Posting*

Nesting habitat for most waterbirds utilizing the Bogue Inlet area consists primarily of dry sand beach above the high tide line, including sand flats, overwash areas and dunes. Habitat suitable for bird nesting should be posted with string and post fencing before the start of the nesting season (i.e., April 1). On the west end of Emerald Isle, this habitat includes the sandy beach above high tide on the spit. Figure 1 depicts the spit as it looks today with the bird nesting area marked. A sound-side forage area will be posted against trespass to allow shorebird chicks and fledglings to forage. The west end of Emerald Isle is expected to change dramatically following the relocation of the channel. It is expected that the spit will reform further south of its present location. Nesting and foraging areas will need to change in response to changing habitat. An example of what the new spit and

nesting and foraging areas may look like is given in Figure 2, but new maps will need to be developed as this area evolves.

The nesting area will be posted from April 1 through August 31 and will consist of 2 x 2 inch posts placed approximately 30 feet apart. Most posts will contain an 8½ x 11 inch sign that states "Bird Nesting Area, Entry Prohibited April 1-Aug. 31". The NCWRC phone number will be listed on the signs so that people can report wildlife violations and obtain information on nest area protection. Additional 8½ x 11 inch educational signs will be placed on some posts to teach beach-goers abonesting waterbirds. Thin, white string will be tied waist high between each post to encourage people to stay out of the nesting area. Orange flagging will be tied along the string to make it more visible. Nesting area string and post fencing will be removed at the end of the breeding season.

Since the nesting area will be posted at the beginning of the nesting season, the size and shape of the area may need to be adjusted as more birds return to nest. A 100-yard buffer will be maintained between nests on the outside of nesting colonies and the string and post fencing. This provides enough distance to prevent birds from flushing off of nests

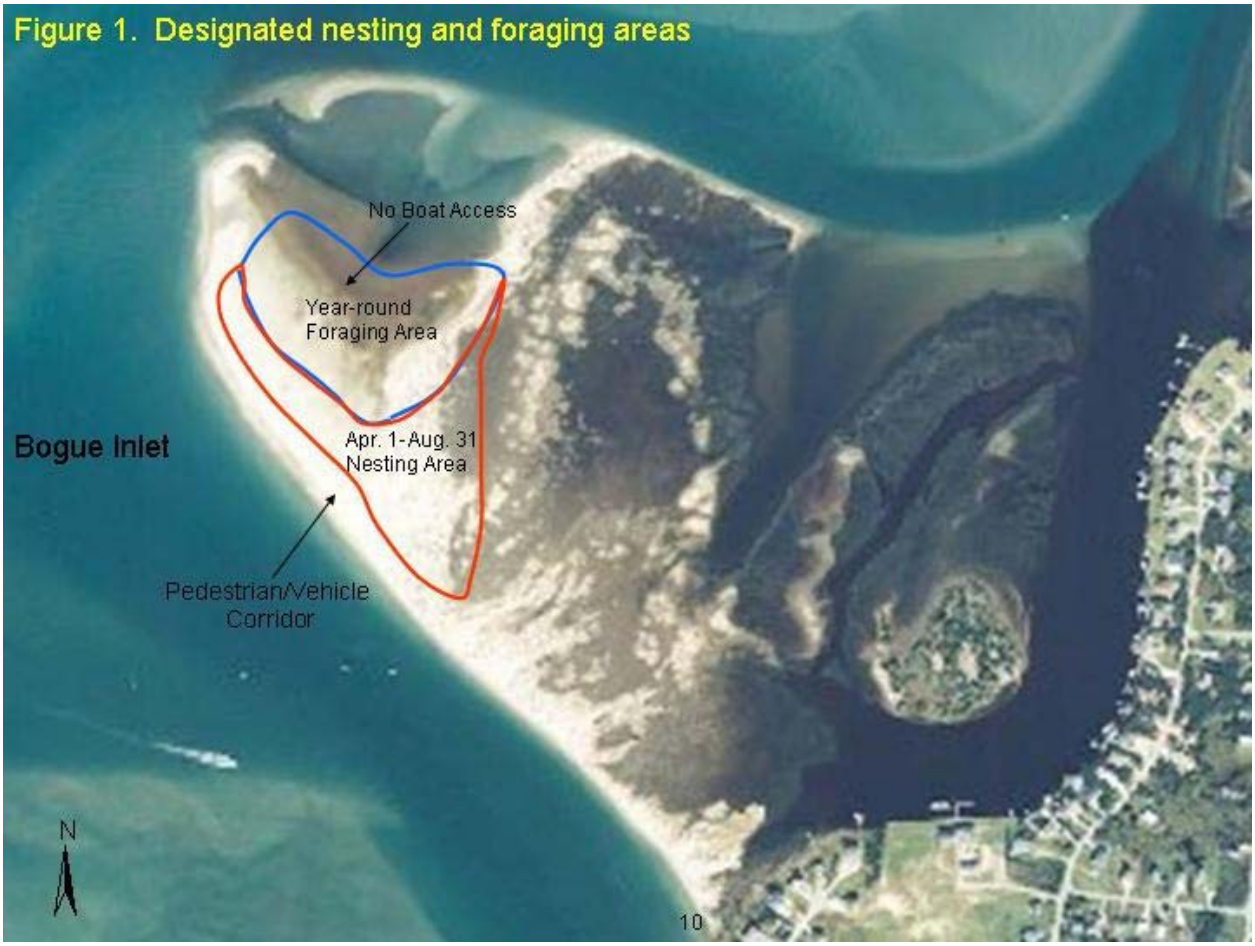
Figure 1. Designated nesting and foraging areas
No Boat Access
Year-round
Foraging Area
Bogue Inlet
Apr. 1-Aug. 31
Nesting Area
Pedestrian/Vehicle
Corridor
N
10

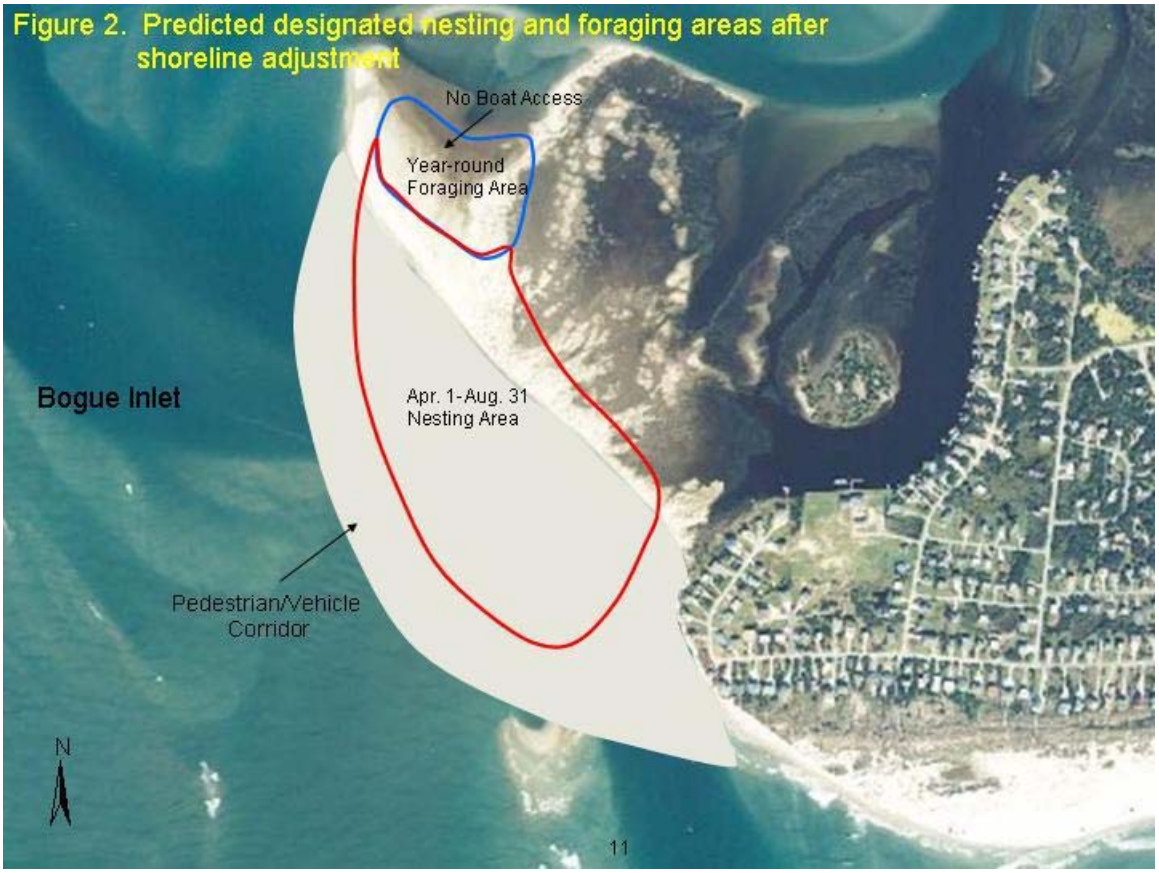
Figure 2. Predicted designated nesting and foraging areas after shoreline adjustment
No Boat Access
Year-round Foraging Area
Bogue Inlet
Apr. 1-Aug. 31 Nesting Area
Pedestrian/Vehicle Corridor
N
11

due to human activity. The nesting area will be constructed in a manor to allow pedestrian access to the oceanfront and inlet shoreline. A corridor of at least 100 feet above the high tide zone along the inlet shoreline will remain outside of the nesting area to allow public access to the oceanfront beach and inlet shoreline. There is a chance that birds will nest in a manner that makes it impossible to have both a 100 yard buffer and a 100 foot pedestrian corridor. If necessary, we will reduce the corridor to up to 25 feet above the high tide line. Beyond that, the 100 yard buffer zone will be reduced. If, later in the nesting season, it is determined that birds are not going to utilize the entire nesting area, it may be possible to shrink the roped off area and make a wider pedestrian corridor. The birds may decide to nest on the newly created dike for the first few years and not on the spit, in which case only the dike would be posted for the entire nesting season.

In addition to posting the west end of Bogue Banks, NCWRC and HBSP will post Island #2 and nesting sites on Bear Island. NCWRC will take over management of the west end of Bogue Banks, albeit in a reduced role, that will include the posting of foraging and nesting areas after the life of the plan (starting in 2008).

5.2 *Ordinances*

Currently, a year-round leash law is in effect in the Town of Emerald Isle. The Town will be responsible for enforcing the leash law to protect nesting birds from roaming pets. To further implement the Management Plan it is recommended that the Town erect signs that inform visitors of the leash law ordinance. Signs noting the ordinance should be placed at all public access points to the spit.

There is currently a moratorium on driving on the beach from April 1 through September 30. Vehicles will be allowed on the spit during the driving window, but will be restricted to the shoreline area (within 150 feet of normal high tide) and required to stay out of designated foraging/roosting areas. Signs will be erected at widely spaced intervals along the upper beach to direct traffic to the shoreline area. It is known that beach driving can have negative impacts on waterbirds (Pfister et al, 1992; USFWS, 1996). Beach driving has the potential to negatively impact birds by crushing birds roosting in tire tracks, causing roosting and foraging birds to flush and degrading nesting and foraging habitat. For this reason, vehicle use will be monitored on an annual basis and the "No Vehicle" zone will be modified if it is determined that vehicles are having a negative impact on foraging and roosting birds and/or on waterbird habitat.

The Town is currently in the process of creating an ordinance to limit pedestrian access within designated waterbird nesting and foraging areas. This ordinance will be similar to the one developed by New Hanover County for the Mason Inlet project (Sec. 38-108. Harassment or harm of birds prohibited) and will includes language

that restricts people from entering posted nesting/foraging areas. People who enter nesting areas will most likely step on nests and may cause nesting colonies to abandon the site completely. In addition, human disturbance during the non-nesting season within foraging and roosting areas may lead to birds being unable to maintain fat reserves and complete migration. Having an ordinance in place will make the job of enforcement much easier, bring enforcement in line with the Migratory Bird Treaty Act and prevent people from violating the Endangered Species Act. Furthermore, it will clarify restrictions to beachgoers and will assist officers who respond to reports of individuals harassing nesting/foraging birds by providing them with a clear and written unlawful action and a mechanism to respond to that action.

5.3 *Predators*

An increase in predator populations can result from increased human usage of an area. Raccoons, foxes and feral cats are attracted to human refuse and can be detrimental to nesting waterbirds. To avoid loss of nests to increased predator populations several steps should be taken. People need to remove their trash from the beach, and fisherman should not leave fish scraps near waterbird nesting areas. A substantial component of this management plan involves educating the public on these issues. In addition, evidence of nest losses will be monitored. If predation is determined to decrease nesting success, then measures such as trapping wild and feral animals will be considered. We recommend the Town place trashcans at all public access points and empty them daily to decrease the occurrence of predators in the waterbird habitat.

6. Protection of Foraging and Roosting Habitat

Prime foraging and roosting habitat exists on the west end of Emerald Isle and includes sound-side intertidal mudflats, intertidal habitat on the ocean facing beach, and supratidal habitat. The sound-side mudflats are heavily used by migrating and wintering shorebirds, including the federally threatened piping plover. A sound-side foraging and roosting area will be designated and closed to public access year-round to allow birds to forage and roost without disturbance from human activities. This area will be posted using 2 x 2 inch posts placed below the low tide line and encircling this prime foraging/roosting site (see Figure 1). Each post will support a sign that reads "Bird Foraging Area – Please Do Not Enter". Boats will not be permitted to land in the designated soundside area and larger "Bird Foraging Area – No Boat Landing" signs will be posted on 4 x 4 inch posts to deter boats from landing in the foraging area. Boats will still be permitted to land at sound-side areas outside of the designated foraging area, and on the inlet beach.

The foraging and roosting area may be adjusted if foraging habitat changes as a result of the channel relocation project. The area to be marked will be determined by waterbird data collected during the winter and migration. New maps will be provided as the area changes. For example, if a salt pond forms on the ocean side as a result of the dike construction, that pond will be protected as foraging habitat since ephemeral pools are known to provide high quality foraging habitat. A string and post barrier around the ephemeral pool to keep people from walking or driving through the area will be sufficient to protect this type of foraging habitat should it form. If the pool dries up, then the area will be open for public access. The ocean and inlet shoreline will, however, continue to be accessible by boats.

Finally, foraging and roosting habitat will be further protected from disturbance by town ordinances that are currently in place and by the creation of an ordinance to prevent trespass within designated areas as discussed under the Nesting Habitat section (5.2).

7. Research/Monitoring of Breeding and Non-breeding Waterbirds

7.1 *Breeding Waterbirds*

Research conducted during implementation of this plan will contribute to our understanding of the impacts that channel and beach stabilization projects and human disturbance have on waterbird nesting, roosting and foraging. Nesting activity will be monitored at the spit on Bogue Banks and Island #2 throughout the nesting season for three years after project construction. A contract biologist will record number of nests of individual species and will also collect data on nesting productivity. For solitary nesters, nests/chicks will be counted and monitored every 3-4 days from lay date to fledging. Counts of colonial nesters will be conducted every three weeks. If the colony is large, a subset of nests will be marked and monitored every 3-4 days to determine nesting success. Chick counts will also be conducted every 3-4 days from outside the colony using a spotting scope. Care will be taken to minimize disturbance to nesting birds and nesting areas will not be entered during adverse weather conditions. In addition, surveys will be conducted during morning hours before 10 am or in the late afternoon to avoid flushing birds during the hottest hours of the day. The Mayfield method (Wilson Bull. 1961, 1975) will be used to calculate survival during critical life-history stages. Every effort will be made to determine the causes of nest losses. Whenever possible, observational data on disturbance will be collected.

In addition to nesting activity on Bogue Banks, regular surveys for waterbirds will be conducted during the breeding season following the methodology of pre-project monitoring (CPE, 2002). Four transects that include the west end of Bogue Inlet, the east end of Bear Island, Dudley Island, and a portion of the mid-inlet shoal

including Islands #1 and #2 will be surveyed every 15 days from May 1 through July 13. Data will be compared with available pre-project data.

7.2 *Migrating/Wintering Waterbirds*

Surveying for non-breeding waterbirds will follow the methodology of pre-project monitoring (CPE, 2002). Monitoring will be conducted every 10 days during spring (March 1 through April 30) and fall migrations (July 14 through November 30) and once per month during the winter (December through February). Monitoring will occur along four transects that include the west end of Bogue Inlet, the east end of Bear Island, Dudley Island, and a portion of the mid-inlet shoal, including Islands #1 and #2. Whenever possible, observational data on disturbance will be collected.

8. Education

A vital component of the waterbird management plan is community outreach and education. Providing opportunities for beach-goers and community members to understand and appreciate the inlet spit as a valuable waterbird resource will instill a desire to protect it. A NCWRC biologist will work at the Bogue Inlet area for three years following project construction to implement the management plan and educate beach-goers about waterbirds. The biologist will concentrate beach patrolling efforts on weekends and holidays to maximize the reduction in disturbance pressure. Organized talks and nature walks for locals and visitors to the beach will be coordinated and conducted by the biologist. An informational kiosk will be constructed at the pedestrian and vehicle access point. NCWRC will provide educational materials to post in the kiosk. NCWRC will begin implementing an educational program and developing a kiosk and education brochures during the fall of 2004.

9. Budget

Table 1. Budget for implementation of the Waterbird Management Plan

	2004	2005	2006	2007	Total
NCWRC Expenses	[$5,000]	[$5,000]	[$5,000]	[$5,000]	[$20,000]
Salary	$7,600.00	$23,000.00	$23,000.00	$23,000.00	$76,600.00
Vehicle Lease	-	$4,034.00	$4,034.00	$4,034.00	$12,102.00
Kiosk	$5,000.00	-	-	-	$5,000.00
Posting materials	-	$1,500.00	$400.00	$400.00	$2,300.00
Boat	-	$650.00	$650.00	$650.00	$1,950.00
Brochures	$800.00	-	-	-	$800.00
Computer	-	$1,200.00	-	-	$1,200.00
Optics	-	$1,600.00	-	-	$1,600.00
Other (phone, internet, office supplies, etc.)	-	$3,000.00	$2,800.00	$2,800.00	$8,600.00
Total (minus NCWRC expenses)	$13,400.00	$34,984.00	$30,884.00	$30,884.00	**$110,152.00**

10. Summary

Along our coastline the dynamic barrier islands on which many waterbirds depend are being severely altered by attempts to stabilize beaches and inlets. If we are to retain habitat for migrating, wintering and breeding waterbirds, it is imperative that we manage remaining habitat in the face of these changes. The ends of barrier islands are particularly valuable to waterbirds and as such should be afforded extra protection. The Bogue Inlet Waterbird Management Plan outlines a strategy to protect nesting, foraging and roosting waterbirds within the project area, to educate the public about waterbirds and to monitor waterbirds utilizing Bogue Inlet. With funds from the Town, NCWRC will implement this adaptive management plan. If it is determined that the objectives of the plan are not being met, new strategies will be discussed and implemented.

11. Literature Cited

Coastal Planning & Engineering. 2002. Piping Plovers, Shorebirds and Colonial Waterbirds Bird Monitoring Program – submitted to USACOE.

LeGrand, H.E. Jr., S.P. Hall and J.T. Finnegan. 2001. Natural Heritage Program list of the rare animal species of North Carolina. North Carolina Natural Heritage

Program, Division of Parks and Recreation. N.C. Department of Environment and Natural Resources. 91 pp.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bulletin. 73: 255-261.

Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bulletin. 87: 456- 466.

Pfister, C., B.A. Harrington and M. Lavine. 1992. The impact of human disturbance on shorebirds at a migration staging area. Biological Conservation 60: 115-126.

USFWS, 1996. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

USFWS, November 2002. Draft Fish and Wildlife Coordination Act Report, Bogue Banks Shore Protection Project, Carteret County, North Carolina.

USFWS, July 2001. Federal Register 50 CFR Part 17: Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for Wintering Piping Plovers; Final Rule. Pp. 36038-36143.

Table 2. List of waterbirds that commonly occur within the Bogue Inlet project area and their status (LeGrand et al, 2001).

Common Name	Scientific Name	Season[1]	NC Status[2]
Brown pelican	*Pelecanus occidentalis*	B, M, W	SR
Double-crested cormorant	*Phalacrocorax auritus*	B, M, W	SR
Great blue heron	*Ardea herodias*	B, M, W	
Great egret	*Ardea albus*	B, M, W	
Snowy egret	*Egretta thula*	B, M	SC
Tricolored heron	*Egretta tricolor*	B, M	SC
Little blue heron	*Egretta caerulea*	B. M. W	SC
Black-crowned night heron	*Nycticorax nycticorax*	B, M, W	
White ibis	*Eudocimus albus*	B, M, W	
Glossy ibis	*Plegadis falcinellus*	B, M	SC
Osprey	*Pandion haliaetus*	B, M	
Clapper rail	*Rallus longirostris*	B, M, W	
Black-bellied plover	*Pluvialis squatarola*	M, W	
Wilson's plover	*Charadrius wilsonia*	B, M	SR
Semipalmated plover	*Charadrius semipalmatus*	M	
Piping plover	*Charadrius melodus*	B, M, W	T (T)
Killdeer	*Charadrius vociferus*	B, M, W	
American oystercatcher	*Haematopus palliatus*	B, M, W	
Greater yellowlegs	*Tringa melanoleuca*	M, W	
Lesser yellowlegs	*Tringa flavipes*	M, W	
Willet	*Catoptrophorus semipalmatus*	B, M, W	
Spotted sandpiper	*Actitis macularia*	M	
Whimbrel	*Numenius phaeopus*	M	
Marbled godwit	*Limosa fedoa*	M, W	
Ruddy turnstone	*Arenaria interpres*	M, W	

Sanderling	*Calidris alba*	M, W	
Semipalmated sandpiper	*Calidris pusilla*	M	
Western sandpiper	*Calidris mauri*	M, W	
Least sandpiper	*Calidris minutilla*	M, W	
Dunlin	*Calidris alpina*	M, W	
Short-billed dowitcher	*Limnodromus griseus*	M, W	
Bonaparte's gull	*Larus philadelphia*	M, W	
Laughing gull	*Larus atricilla*	B, M	
Ring-billed gull	*Larus delawarensis*	M, W	
Herring gull	*Larus argentatus*	B, M, W	
Great black-backed gull	*Larus marinus*	B, M, W	
Gull-billed tern	*Sterna nilotica*	B, M	T
Caspian tern	*Sterna caspia*	B, M, W	SR
Royal tern	*Sterna maxima*	B, M, W	
Sandwich tern	*Sterna sandvicensis*	B, M	
Common tern	*Sterna hirundo*	B, M	SC
Forster's tern	*Sterna forsteri*	B, M, W	
Least tern	*Sterna antillarum*	B, M	SC
Black tern	*Chlidonias nigra*	M	
Black skimmer	*Rynchops niger*	B, M	SC

[1] Season
B = Breeding; M = Migrating; W = Wintering

[2] NC Status
Endangered (E); Threatened (T); Special Concern (SC); Significantly Rare (SR). E, T, and SC status species are given legal protection status by the NC Wildlife Resources Commission. SR status is defined as any species which has not been listed by the NC Wildlife Resources Commission as E, T, or SC species, but which exists in the state in small numbers and has been determined by the NC Natural Heritage Program to need monitoring. Federal status is indicated in parentheses.